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Jordan's remarks apply to the species resembling *P. bolcanus*. C. R. EASTMAN.

HARVARD UNIVERSITY,
CAMBRIDGE, MASS.

THE ASCENT OF WATER.

TO THE EDITOR OF SCIENCE: The identity between leaves and roots of trees which is signalized by the criticism in your last issue probably signifies that they have the same sort of resemblance as the entrance and exit of a building. But the critic can not be entirely ignorant of the recent researches which establish their antithetical relation so far as the contention of my paper is concerned. Near the leaves the ducts have an extreme vacuum, so long as transpiration from the leaf-surface continues; this vacuum diminishes downwards towards the base of the stem, as in a suction pump; and the inward current of water at the base is still dependent (when root-pressure is inactive) on a difference between the atmospheric pressure and the tension within the ducts. The results and authorities are summarized in Pfeffer's 'Physiology,' also in E. B. Copeland's paper in *Botanical Gazette* (October 19, 1902), and in Livingston's valuable book on 'The Rôle of Diffusion.' Whilst using these results my paper added nothing to them. Its only aim was to remove a stumbling block which was caused by the tortious assumption that atmospheric pressure can not lift water more than 1033 centimeters high. As the mixture of air and water within the ducts appears to be in the condition of foam, such pressure probably suffices to elevate it to the top of the loftiest trees. This is the part that ought to be criticized.

I am much obliged to the editor of SCIENCE for permitting me to submit the facts to his great constituency. And now I wish to withdraw from the case, and to leave its further consideration to others. G. MACLOSKIE.

PRINCETON UNIVERSITY,
August 8, 1904.

ANALYSIS OF A COMPLEX MUSICAL TONE.

THE analysis of a musical tone by means of Helmholtz's resonators makes a good lecture experiment when so carried out as to be heard

by a large audience. Whether this has been accomplished by others I do not know, but I have succeeded as follows: A telephone receiver is connected to alternating current lighting mains (frequency 133 cycles per second) through a resistance sufficient to reduce the current to about $\frac{1}{2}$ ampere. The telephone then emits a tone having a fundamental pitch of 266 vibrations per second, and of which the overtones are prominent.

An adjusted resonator held over the mouth of the telephone strengthens the overtone to which it is tuned so as to make the overtone easily audible throughout a large room.

I have had no difficulty in demonstrating eight successive overtones in this way.

W. S. FRANKLIN.

SPECIAL ARTICLES.

THE EFFECT OF RADIUM RAYS ON THE COLON BACILLUS, THE DIPHTHERIA BACILLUS AND YEAST.

THE discovery that rays emitted from salts of radium may be used therapeutically in the treatment of some diseases, has opened an interesting field for conjecture as to the manner in which these rays act, and naturally suggests experiments concerning their effect on bacteria in general, and especially on specific micro-organisms.

A few investigators have already published results of such experiments. Pfeiffer and Friedberger,* for example, found that typhoid fever bacilli were destroyed by exposure to the action of radium rays for forty-eight hours at a distance of about 1 cm., but not at 5 cm. distance. They found further that the bacteria only were affected, and that the culture medium remained unchanged. Anthrax spores dried on silk threads were destroyed after exposure for three periods of twenty-four hours each, but not after two twenty-four-hour exposures. G. Bohn† has also reported that 'lower organisms' are quickly destroyed by the action of radium rays.

* Pfeiffer, R., and Friedberger, E., 'Ueber die bakterientötende Wirkung der Radium-Strahlen,' *Berl. klin. Wochenschrift*, 1903, No. 28.

† Bohn, G., 'A propos de l'action toxique de l'emanation du radium,' *Soc. Biol.*, 55, p. 1655.

On the other hand Van Beuren and Zinsser,* as a result of a small number of experiments, were unable to ascribe with certainty any bactericidal properties to radium, and explained the few cases in which harmful action seemed to have resulted as due to the experimental error of the methods employed.

At the suggestion, and through the kindness, of Dr. Francis H. Williams, of Boston, who has employed radium in practice with marked success, I was recently enabled to make, under favorable conditions, some experiments to determine the effect, if any, of a brief exposure to radium rays of two well known species of bacteria (the common intestinal bacillus and the bacillus of diphtheria), and one blastomycetous fungus (yeast).

The radium salt used in my experiment was the pure bromide having an estimated radio-activity of 1,500,000 units. This salt emits three distinct sets of rays, known respectively as the alpha, the beta and the gamma rays. Of these the alpha rays are lacking in power and are readily absorbed by most substances, as, for example, by a mica plate, or a sheet of paper, so that they are without special interest in this connection. The beta rays are absorbed by certain substances, aluminium, for example, but if not cut off by these may be active at short distances, perhaps within five centimeters. The gamma rays are active at greater distances, even up to several meters, and are not readily absorbed. The number of gamma rays to beta rays is about one to fifteen.

It is easy to observe the combined action of the beta and gamma rays by exposing a culture of micro-organisms at a short distance from the radium, and the effect of gamma rays alone can be determined by interposing an aluminium screen of about one eighth inch in thickness. In my experiments the radium was enclosed in a metallic capsule closed on the upper side with a thin mica plate, and the whole was then covered by stretching over it a thin coat of rubber. Neither beta nor gamma rays were thus intercepted.

* Van Beuren, F., and Zinsser, H., 'Some Experiments with Radium on Bacteria,' *American Medicine*, December, 1903.

The first series of experiments was made upon the intestinal bacillus (*B. coli*), this being taken as a typical nonspore-forming organism, comparatively sensitive to environmental conditions. Active bacteria from streak cultures twenty-four to forty-eight hours old were inoculated into freshly poured agar plates. In some cases the organisms were spread out in thin surface films forming spots perhaps 5 cm. in diameter, while in other cases intersecting lines were drawn upon the surface of the agar with an infected needle. The plate cultures thus prepared were then exposed to the action of radium rays for different length of time, and at various short distances.

The radium capsule was fixed, mica-side up- permost, on a sterilized plate-glass table, and a plate culture, the cover having been removed, was inverted above it, and so placed that the infected area was exactly over and near the mica window. Protection from dust was secured by covering with a sterilized glass bell-jar. After the exposure the cultures were removed, their covers replaced, and the bacteria incubated for twelve to twenty-four hours at 37°. Control plates were made in every case, and the two sets were carefully examined, the general and microscopical appearance of the cultures, and the culture characteristics being noted.

Organism.	Distance from Radium.	Time of Exposure.	Result.
<i>B. coli</i>	2 cm.	20 min.	Negative. Growth not inhib.
" "	1 "	20 "	" " " "
" "	2 "	30 "	" " " "
" "	1 "	30 "	" " " "
" "	1 "	40 "	" " " "
" "	1 "	45 "	" " " "
" "	1 "	50 "	" " " "
" "	1 "	60 "	" " " "
" "	1 "	75 "	" " " "
" "	1 "	80 "	" " " "

At the outset brief exposures were made at distances of one and two centimeters. These having failed to show that the radium had any inhibitory or deleterious effect, the time of exposure was gradually increased in later experiments and the distance restricted to one centimeter or slightly less. Careful scrutiny failed to show that the radium had any harmful

action upon the bacteria. Details are given in the following table.

The action of radium rays upon the diphtheria bacillus (*B. diphtheriæ*) was next studied, the methods employed being the same as with *B. coli*. This organism was selected (1) because it may be regarded as a typical pathogenic microbe; and (2) because it has been suggested that radium, on account of its germicidal action, may be conveniently applied in the treatment of diphtheria. In such treatment the radium is to be encased in special tubes (to be obtained from dealers in radium) and these tubes inserted in the throat, whereupon, it has been claimed, the organisms will be destroyed. It has even been hinted that radium may replace antitoxin in medical practice.

Two cultures of *B. diphtheriæ* were experimented upon—one a laboratory culture of several generations since isolation, the other a recently isolated, virulent culture. As with *B. coli* the length of the exposure to the action of radium varied considerably, and in all cases the results were negative, as will be seen from the table.

Organism.	Distance from Radium.	Time of Exposure.	Result.
<i>B. diphtheriæ</i>	2 cm.	20 min.	Neg. Growth not inhib.
" "	1 "	20 "	" " " "
" "	2 "	30 "	" " " "
" "	1 "	30 "	" " " "
" "	1 "	40 "	" " " "
" "	1 "	50 "	" " " "
" "	1 "	60 "	" " " "
" "	1 "	70 "	" " " "
" "	1 "	80 "	" " " "

No experimental evidence whatever was obtained which would indicate that any degree of success can be hoped for in treating diphtheria by destroying the specific micro-organisms by means of radium rays.

A few experiments were also made to determine the action of radium on fungi other than bacteria, and for this purpose domesticated yeast (*Saccharomyces cerevisiæ*) was employed as a type of the blastomycetes. The method differed from that used with *B. coli* and *B. diphtheriæ* only in the fact that a wort-gelatine medium replaced nutrient agar, and that the plates were incubated at 25° instead

of at 37°. As in the experiments with bacteria, negative results only were obtained, the most careful scrutiny failing to reveal any destruction, or even any inhibition, of the life or growth of the micro-organisms.

Organism.	Distance from Radium.	Time of Exposure.	Result.
<i>Sac. cerevisiæ</i>	1 cm.	20 min.	Neg. Growth not inhib.
" "	1 "	30 "	" " " "
" "	1 "	40 "	" " " "
" "	1 "	60 "	" " " "
" "	1 "	80 "	" " " "

These experiments and the conclusions to be drawn from them may be summarized by the following statements.

1. Radium rays have no effect upon fresh cultures of *B. coli*, *B. diphtheriæ*, or *Saccharomyces cerevisiæ* at a distance of one centimeter when the time of exposure is less than ninety minutes.

2. Any advantages derived from the therapeutic use of radium must be explained in some other way than by the direct weakening or destruction of the micro-organisms of disease.

3. The use of radium tubes in the treatment of diphtheria can not be recommended or regarded as a substitute for antitoxin.

In conclusion, I desire to express my obligation to Dr. F. H. Williams for the opportunity to carry on these experiments, and for many helpful suggestions. S. C. PRESCOTT.

THE BIOLOGICAL LABORATORIES,
MASS. INST. TECHNOLOGY,
July 30, 1904.

A WHEAT-RYE HYBRID.

TO THE EDITOR OF SCIENCE: A few preliminary notes as to distribution of parental characters observed in the above type of hybrid grown by the writer during the present season may be interesting. The cross was obtained in May, 1903, by using a Russian variety of rye as the pollen- and Jones' Winter Fife as the seed-parent. No reciprocal crosses were attempted. Several seeds resulted, of which a few showed apparent xenia, the blue-gray color of the rye seed-coat being very evident